Smart Bracket Assembly for Forming Press

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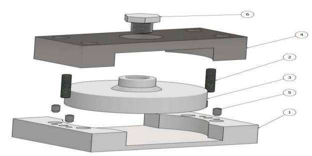
Abstract

This project focuses on automating and standardizing the crowning process of a 15-foot Farnham roll form machine, used to shape aluminum parts, including fuselage and wing skins. The current crowning adjustment compensates for force imbalances caused by screws positioned at the machine's ends and requires extensive manual shimming for optimal contact along 18 adjustable brackets. This process is detrimental to the manufacturing flow, as the time it takes to adjust the Farnham Press for different types of sheet metal or bends is long enough to significantly slow down production. To streamline this process, the project's objectives are to design a method to measure bracket-to-material contact accurately, create an adjustable bracket system without the need for shims, and provide operators with real-time measurement feedback to optimize crowning adjustments efficiently. This will be achieved by redesigning the brackets with integrated sensors to accurately read the changing force along the beam. Progress to date includes multiple bracket designs developed by the mechanical team, featuring adjustable mechanisms such as vertical screws, wedges, and easily insertable shims for depth control. Concurrently, the electrical team has conducted extensive research into sensor options and collaborated with sensor companies to identify suitable measurement solutions. Efforts are also underway to establish a data display interface that can provide real-time readouts from all 18 sensors, enabling operators to make informed adjustments during operation. Future work aims to explore a CNC-style interface for full control automation, which would allow streamlined adjustments for different part profiles and material thicknesses. This approach is expected to significantly reduce setup time and improve consistency in part quality.

Sensor housing

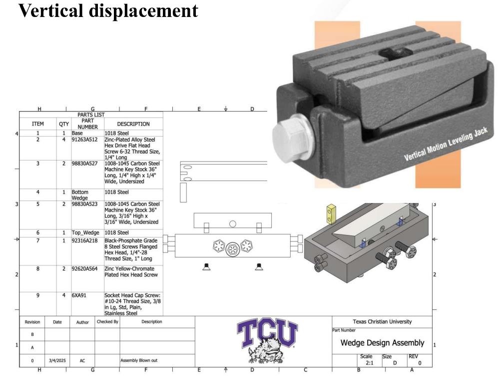
We have designed a sensor housing to hold the most expensive part of our project, the sensors. A crucial requirement for all sensors is that they should be evenly supported along the total circumference of the base. Additionally, the load should be transferred through the threads of the button on top of the load cell strictly vertically. The current design features a bracket assembled with screws that run from the gantry down to the rollers. A two-side assembly for the housing: one piece positioned underneath the sensor, providing ample support to the bottom circular section of the sensor, and a top housing which will transfer the load from the gantry into the threads of the iLoad Pro. This will form a "sensor sandwich," with the sensors resting between the two bracket components. Additionally, a 0.003" gap will be intentionally integrated in between the two housings when at rest by the means of threaded inserts. This serves as an additional safety factor as the manufacturer specifies that the iLoad Pro will deform by 0.003" at the usable max capacity.



Sensor

For this project our sensor being used is the ILoad Pro from Loadstar sensors. The iLoad Pro comes pre-calibrated and the sensor's ease-of-use is better than other sensors because it does not require a signal conditioner and data acquisition system to collect data. After initial load testing of the press, a maximum of 350 lbs. per bracket was recorded. Given this information, the iLoad Pro sensor rated for 1000 lbs. was selected to balance a favorable factor of safety with minimal accuracy skews.

Vertical displacement

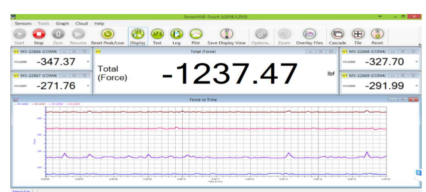


Components

In the final assembly of our design there are 19 components without accounting for repeatable parts. This means that there are over 342 components when accounting for all 18 brackets.

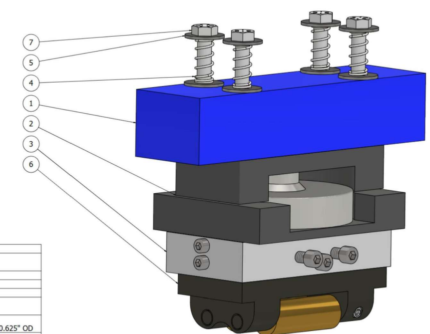
Software

The Smart Roller Bracket Assembly project integrates SensorVUE, a multi-channel software solution by Loadstar® Sensors, specifically designed to handle data from multiple sensors simultaneously. SensorVUE enables real-time data visualization, logging, and analysis for force, weight, torque, pressure, and other measurements. This flexibility ensures accurate calibration, monitoring, and feedback for optimizing the crowning adjustment process. Unlike single-channel solutions, SensorVUE efficiently manages data from all 18 load cells in this project, offering a unified and robust platform.



Final Design

The final design we reached was a blend of previous designs with improvements at every level. The Sensor housing has a fail-safe mechanism which doesn't allow the sensor to receive the sensor max of 1,000lbs. The vertical adjustment device has evolved into a sophisticated but simple way to adjust the vertical displacement by a max of 0.25". The bracket was modified from the original bracket to optimize the limited vertical space. We also modified the length of the rollers that come in contact with the material. This increased surface area should help with uniformity.



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Gantry	
2	1	Sensor_Assembly	
3	1	Wedge_Assem	
4	4	9657K308	Compression Spring 1" Long, 0.42" OD, 0.326" ID
5	8	92141A225	18-8 Stainless Steel Washer for Number 16 Screw Size, 0.313" ID, 0.625" OD
6	1	Roller_Bracket_Assembly	
7	4	91257A445	Zinc Yellow-Chromate Plated Hex Head Screw Grade 8 Steel, 5/16"-24 Thread Size, 5" Long

Revision	Date	Author	Checked By	Description
B				
A	3/18/25	ADH	ADH	Full Assembly | Parts List
0				

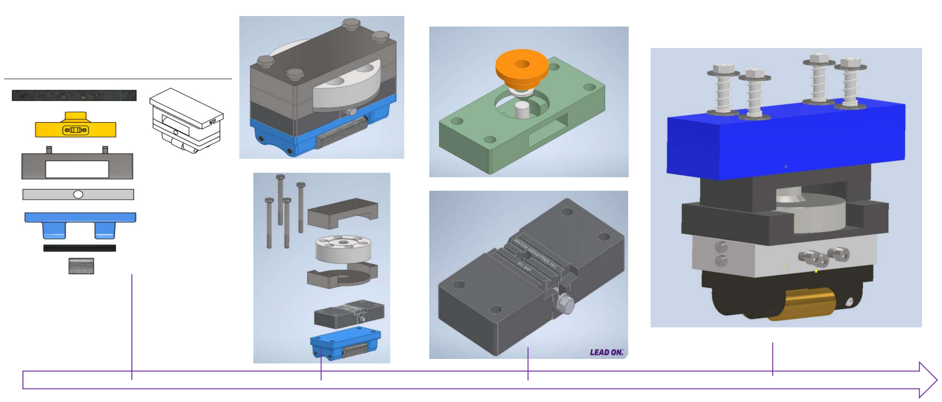
Texas Christian University

Part Number: Full Assembly

Scale | Size D | REV

Evolution of Design

As our project developed, our design changed many times and evolved into our final design. At the beginning we started brainstorming different ways to incrementally adjust the height of the assembly to counteract the crowning affects from the roller press.



Testing

Testing is a very important aspect of this project as it validates our design. This meant that before buying the materials and making the other 17 bracket assemblies, we had to test that our design does displace vertically, the sensor provides a readout under load, and that the design withstands up to 1,000 lbf. To do this, we used an instrument called an INSTRON testing machine before the full assembly at Aero. Full assembly testing at Aero begins with preparation, ensuring proper setup and alignment, followed by static load tests at different height settings for each model. The sensor housing is tested separately for structural integrity. The full bracket assembly undergoes static load tests, repeated 5-8 times if results vary. On-site testing at Aero involves confirming material requirements, safe installation, and alignment verification. The system undergoes visual inspections, static load tests, and operational checks under various settings. Data is collected, analyzed for trends, and evaluated for performance and safety. Uniform force application on the sensor is a key focus. Safety assessments identify risks and recommend mitigations. Findings guide further modifications and improvements. A comprehensive report includes test data, observations, and recommendations. Documentation consists of photos, charts, and relevant notes for reference and validation.

Conclusion

In conclusion, the project successfully achieved the design and testing of an automated crowning solution, along with the development of a sensor-integrated bracket system. These advancements have significantly improved manufacturing efficiency for Aero Components, while also enhancing process standardization. The potential for broader industry applications further underscores the project's impact and its promise for future development.